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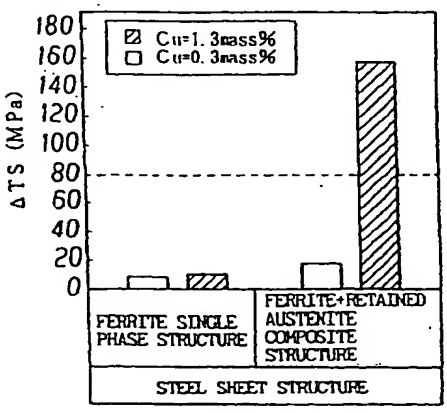
(54) High-ductility steel sheet excellent in press formability and strain age hardenability, and method for manufacturing the same

(57) A steel sheet composition contains appropriate amounts of C, Si, Mn, P, S, Al and N and 0.5 to 3.0% Cu. A composite structure of the steel sheet has a ferrite phase or a ferrite phase and a tempered martensite phase as a primary phase, and a secondary phase containing retained austenite in a volume ratio of not less than 1%. In place of the Cu, at least one of Mo, Cr, and W may be contained in a total amount of not more than 2.0%. This composition is useful in production of a high-ductility hot-rolled steel sheet, a high-ductility cold-rolled steel sheet and a high-ductility hot-dip galvanized steel sheet having excellent press formability and excellent stain age hardenability as represented by a ΔTS of not less than 80 MPa, in which the tensile strength increases remarkably through a heat treatment at a relatively low temperature after press forming.

Fig. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 02 01 2388

DOCUMENTS CONSIDERED TO BE RELEVANT

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A	* paragraphs [0062]-[0078] *	7-11	
A	* paragraphs [0119]-[0134] *	17-22	
A	* paragraphs [0182]-[0201] *	30-37	
X	EP 0 945 522 A (KAWASAKI STEEL CO) 29 September 1999 (1999-09-29) * paragraphs [0010],[0011],[0013]; claims 1,9,10; table 3 *	1,2,12	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	27 February 2003	Swiatek, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

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EUROPEAN SEARCH REPORT

Application Number
EP 02 01 2388

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims

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MUNICH	27 February 2003	Swiatek, R

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 02 01 2388

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims: 1-4,7,8,11

A steel sheet made of a Mn steel containing Cu and having a structure comprising a ferrite phase and a retained austenite phase. The method for its production contains specified steps of hot rolling, multi stage cooling after finish rolling and coiling.

2. Claims: 1-4,17,18,21,22

A steel sheet made of a Mn steel containing Cu and and having a structure comprising a ferrite phase and a retained austenite phase. The method for its production contains steps of hot rolling, cold rolling, recrystalisation annealing, cooling and heat treating.

3. Claims: 1-4,23,30,31,34-37

A steel sheet made of a Mn steel containing Cu and having a structure comprising a ferrite phase and a retained austenite phase. The method for its production contains heating above A1 temperature, rapidly cooling, heating again to a temperature between A1 and A3 and hot-dip galvanizing.

4. Claims: 1,2,5,6,9-11

A steel sheet made of a Mn steel containing at least 1 element from the group: Mo, Cr or W and having a structure comprising a ferrite phase and a retained austenite phase. The method for its production contains specified steps of hot rolling, multi stage cooling after finish rolling and coiling.

5. Claims: 1,2,5,6,19-22

A steel sheet made of a Mn steel containing at least 1 element from the group: Mo, Cr or W and having a structure comprising a ferrite phase and a retained austenite phase. The method for its production contains steps of hot rolling, cold rolling, recrystalisation annealing, cooling and heat treating.

6. Claims: 1,2,5,6,23,32-37

A steel sheet made of a Mn steel containing at least 1 element from the group: Mo, Cr or W and having a structure

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
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comprising a ferrite phase and a retained austenite phase. The method for its production contains heating above A1 temperature, rapidly cooling, heating again to a temperature between A1 and A3 and hot-dip galvanizing.

7. Claims: 1,12-14,24

A cold rolled steel sheet made of a Mn steel containing Cu and having a structure comprising a ferrite phase and a retained austenite phase. The sheet has a hot-dip galvanized layer on its surface.

8. Claims: 1,12,15,16,24

A cold rolled steel sheet made of a Mn steel containing at least 1 element from the group: Mo, Cr or W and having a structure comprising a ferrite phase and a retained austenite phase. The sheet has a hot-dip galvanized layer on its surface.

9. Claims: 1,25-27

A steel sheet made of a Mn steel containing Cu and having a structure comprising a ferrite phase, a retained austenite phase and a tempered martensite phase.

10. Claims: 1,25,28,29

A steel sheet made of a Mn steel containing at least 1 element from the group: Mo, Cr or W and having a structure comprising a ferrite phase, a retained austenite phase and a tempered martensite phase.

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Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	27 February 2003	Swiatek, R

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